

## 6 Severe Weather

### 6.1 General Description

Severe weather from thunderstorms occurs in all sections of the state. Due to low population density and geographic location, life and property losses are generally quite low. Severe weather impacts on economic sectors spans the field.

### 6.2 Thunderstorms

The number of stations with thunderstorm records is fairly limited. An observation that records a thunderstorm is based on whether thunder is heard. Even though thunder may be heard, it does not mean that rain, hail, strong winds or lightning occurred at the station. Based on available thunderstorm data, Figure 1 was created showing the distribution of thunderstorm across the state. June and July have the most thunderstorms. The frequency of thunderstorms ranges from about 40 days in portions of the southwest, 35 to 40 in the southeast, and less than 15 in the Cut Bank area.

Mean Annual Thunderstorm Days

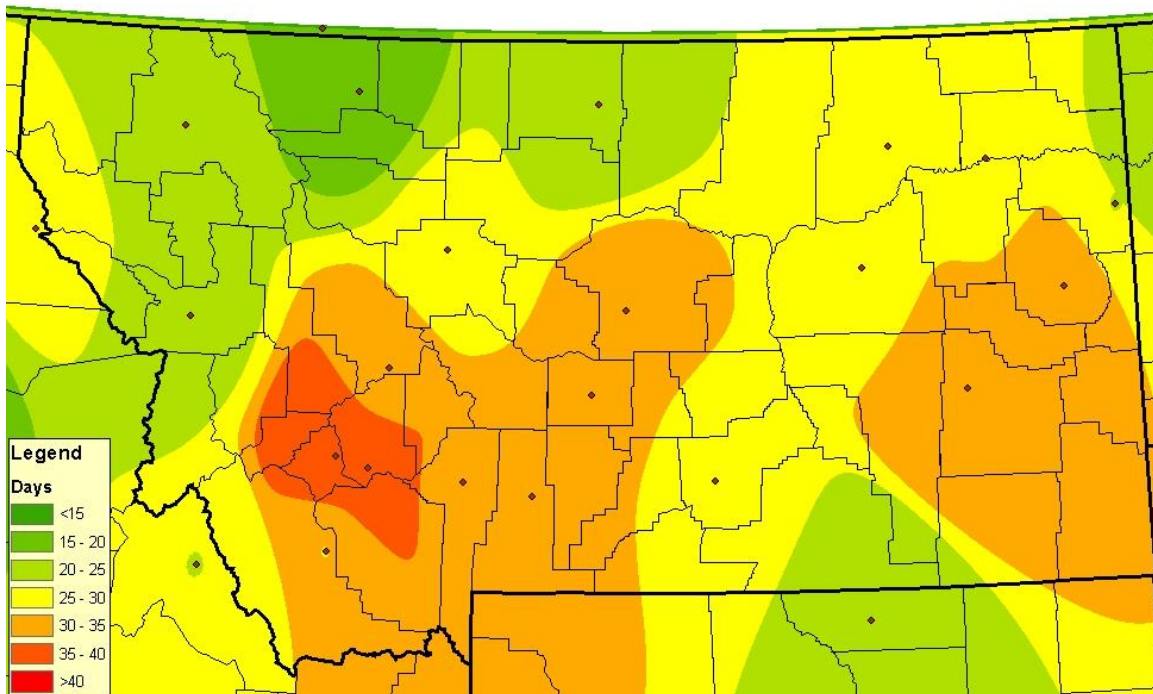


Figure 1. Mean annual number of days with thunderstorms.

While the number of days with thunderstorms varies across the state, the number of days with severe weather peaks in June and July. In each of these months, nearly 12 days of severe weather can be reported at some location in the state (Figure 3). Severe weather associated with thunderstorms includes tornadoes, large hail, and/or high winds. In

general, the thunderstorm season in Montana runs from May through September, with the majority of thunderstorms occurring from late May to mid-July. The thunderstorm occurrence drops sharply in mid-July as the state enters its warm and dry season. There is a secondary peak in thunderstorm activity in August, with another rapid decrease in occurrence in September (Figure 4).

Wind gusts from thunderstorms are generally greater than 45 mph. A severe thunderstorm has winds of 58 mph or greater. Peak wind gusts by county are shown in Figure 2. Not all gusts are from thunderstorms. Those along the Rocky Mountains are generally from strong Chinook winds during the cool season.

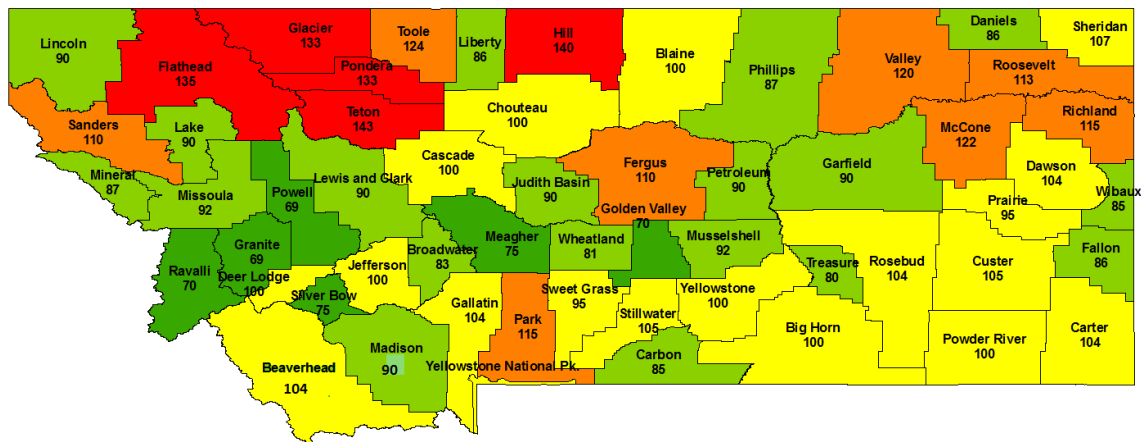


Figure 2. Peak wind gusts by county (1950-2014)

Thunderstorms have different characteristics across the state. West of the divide, though severe thunderstorms are possible, they are of a weaker variety. Large hail and tornadoes over the west are rare. The continental divide and eastward is the area where severe thunderstorms are more common. Thunderstorms generally develop over the higher terrain of the southwest, then drift northeastward and intensify in a deeper moist and unstable air mass over the plains. Thunderstorms tend to become more organized and long-lived over the far eastern plains, sometimes becoming mesoscale convective complexes, or precursors to derechos. Thunderstorm characteristics also vary seasonally. Late spring and early summer thunderstorm often bring hail, with instances of high wind.

The later season thunderstorms bring more high wind events as the atmosphere dries climatologically and the thunderstorm bases are higher. There are also rare winter-time severe thunderstorms. These are generally limited to an area along and 125 miles east of the continental divide across central and northern Montana. These generally bring high winds.

The highest reported thunderstorm gust occurred on July 30, 1957 when a gust to 140 mph was reported at the Coast Guard radar station north of Havre.

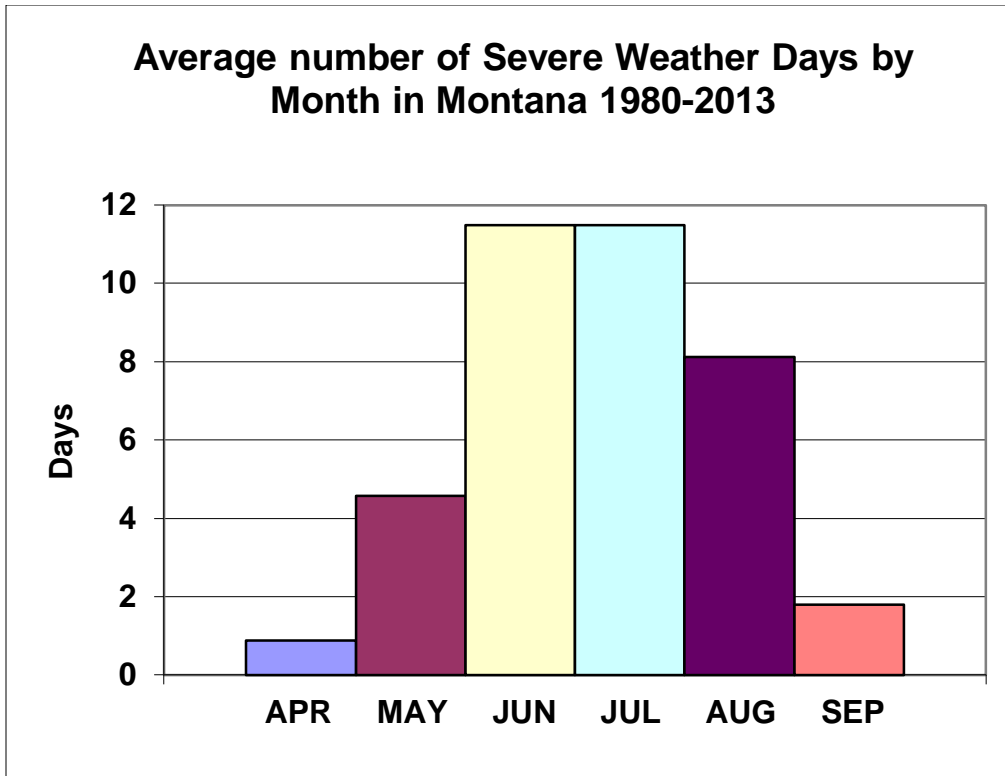


Figure 3. Number of severe weather days by month

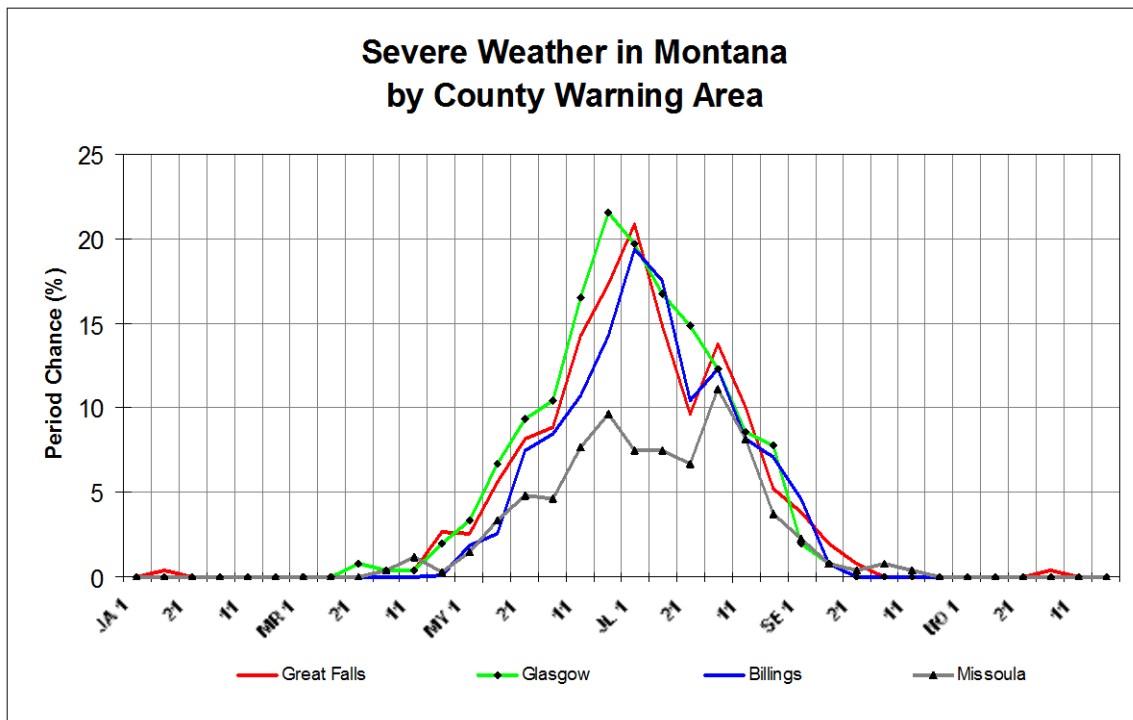


Figure 4. Average incidence of severe weather across Montana stratified by 10-day period and County Warning Area. The date is the center point of the 10-day average. (1980-2013).

## 6.3 Lightning

Statistics in the U.S. reveal that 1 in 345,000 lightning flashes results in a death and 1 in 114,000 results in an injury. Montana ranks in the top 10 in number of lightning fatalities. In Montana, hikers should be off exposed mountain tops and ridges by 2 pm during the summer months. Outdoor activities during the summer expose many people to lightning hazards. Lightning stroke frequency maps show that the highest frequency of lightning strikes is across southern, and especially southeastern Montana. Figure 5 shows that the greatest concentration of lightning strikes are across southeastern Montana, with a secondary maximum in the Butte area. The lowest concentration is across the northwest.

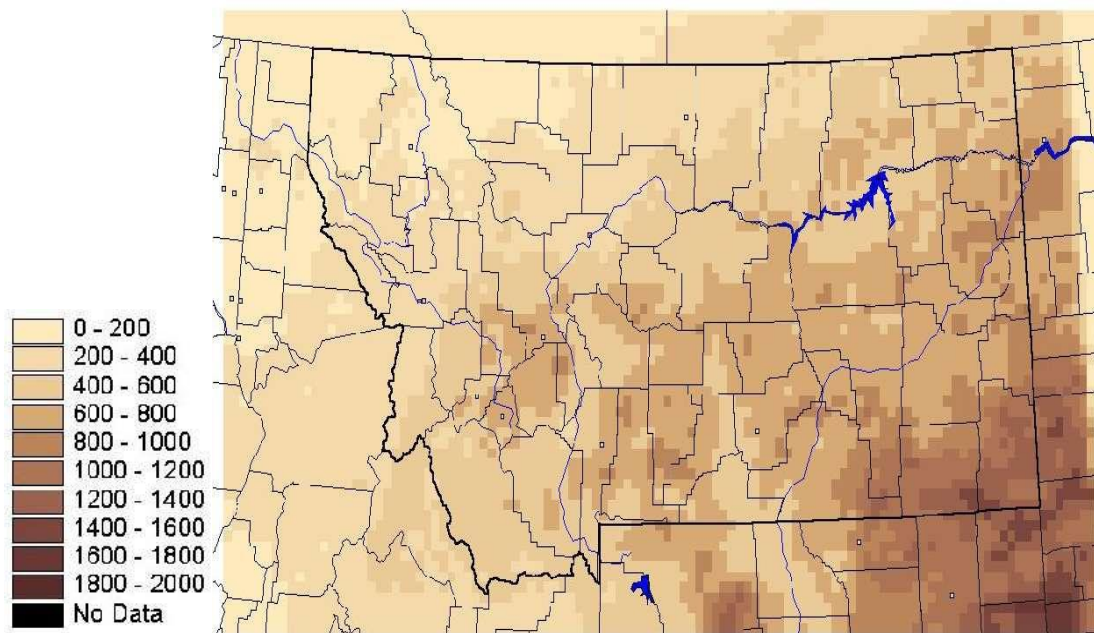


Figure 5. Total lightning strikes 1989-1997.

## 6.4 Tornadoes

Tornadoes are not uncommon in Montana. Tornadoes have preferred areas of occurrence, including central Montana near the Little Belt and Big Snowy Mountains, and the eastern one-third of Montana, associated with super cells (Figs. 6-8). For the state, an average of 11 tornadoes is reported each year (as of 2014). Figure 5 shows the distribution of tornadoes by county from 1950-2005. Central Montana is influenced by shear around the central Montana island ranges, while eastern Montana storms have a higher frequency of vertical wind profiles that enhance inflow into storms and evolution into super cells. There is also the influence of population density on tornado reporting. The counties with higher population density east of the divide have reported more tornadoes. The most damaging tornado in Montana's history occurred on June 20, 2010 when an EF2 tornado struck Billings. It moved across the MetraPark and caused \$45 million in damage.

Montana Number of Tornadoes per 10,000 sq miles (1950-2012)

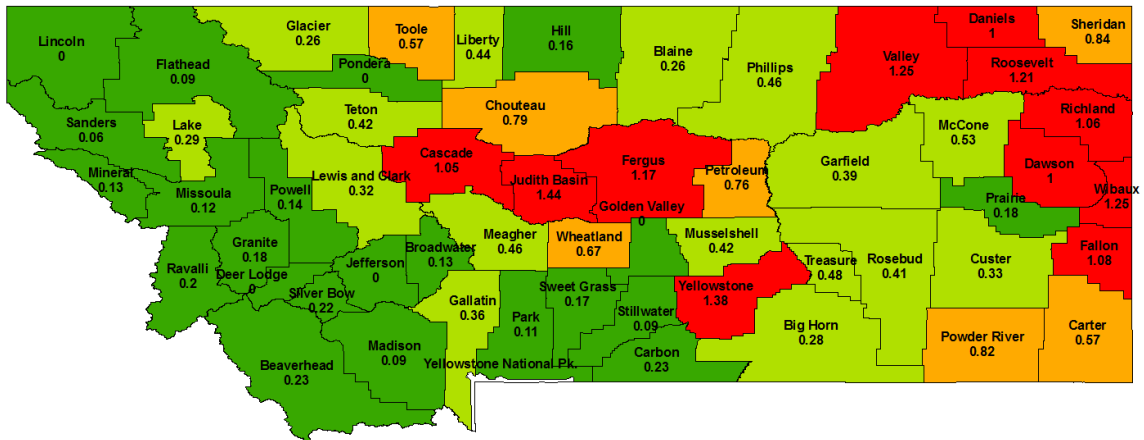


Figure 6. The number of reported tornadoes in each county per 10,000 square miles.

Montana Number of Tornadoes (1950-2012)

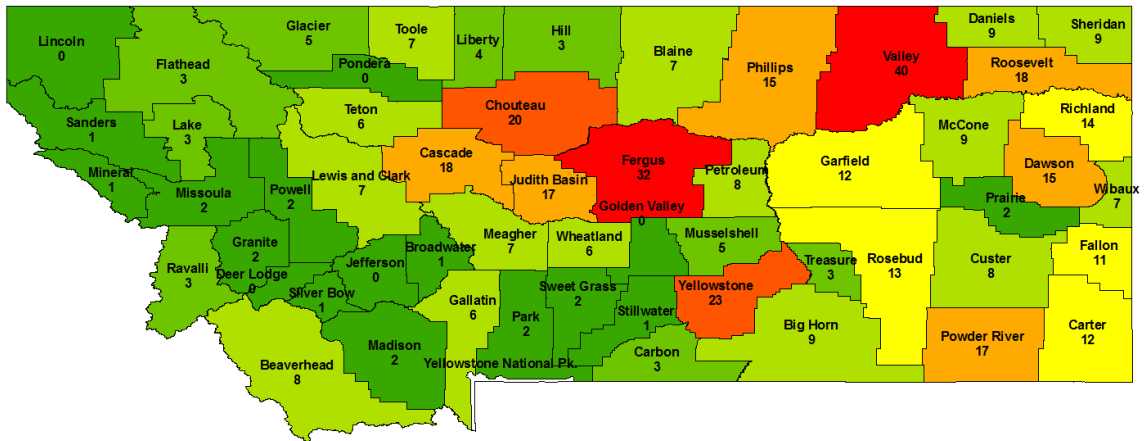


Figure 7. Total number of reported tornadoes per county.

Montana Highest Rated F-scale Tornado (1950-2012)

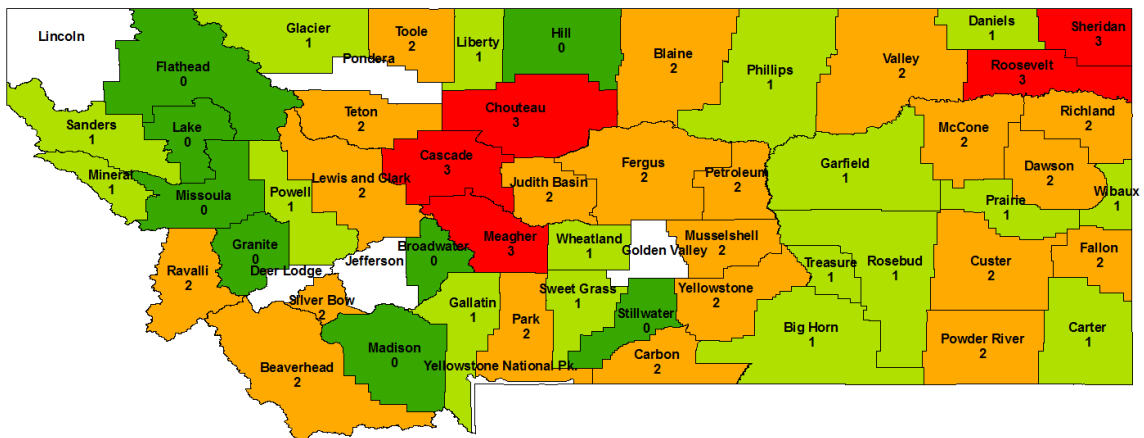


Figure 8. Highest rated F-scale tornado by county.

Despite an average of 8 tornadoes per year in Montana (1981-2014 average), only seven fatalities have been reported in the state's history, and only a few injuries. The low number of fatalities can be explained in part, by the few numbers of tornadoes per year, the weakness of most tornadoes that occur in the state, and by the state's low population

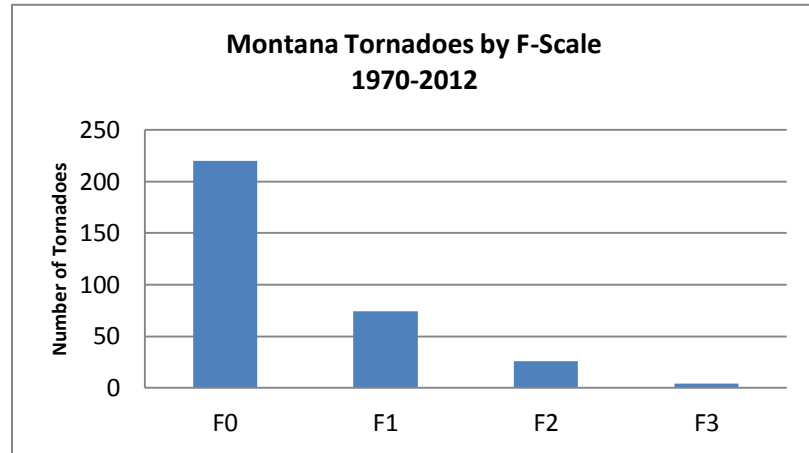


Figure 9. Tornado frequency by F-scale.

density. Since the mid-1980s, tornado strength has been assigned a number based on the Fujita Scale, or F-scale (Fujita 1981). This scale ranks tornadoes by damage, with F0 the weakest and F5 the strongest. It is important to note the damage intensity was developed to relate wind speed ranges to level of structural damage. With a low population density, and wide distances between structures in Montana, the Fujita scale is at times, difficult to apply. The F-rating is assigned based on the extent of damage, rather than the size of the funnel. The highest percentage, by far, are F0 tornadoes. There have been 26 F2 tornadoes in Montana since 1970. Figure 9 shows the reported Montana tornadoes since 1970, separated by F-scale. This was changed to the Enhanced Fujita scale around 2006. This is now referred to as the EF-scale.

The tornadoes resulting in the most deaths occurred on two different dates. On June 10, 1923, two miners in Mineral County were killed when a tree fell on them. On July 26, 2010, an EF-3 tornado moving southeast through Sheridan County killed two people.

The tornado resulting in the most damage occurred on June 20, 2010. An EF-2 tornado tore through eastern Billings and caused \$45 million in damage. It hit the Rimrock Automall causing extensive damage. On August 14, 1999 an F2 tornado moved northward through Lewistown causing significant damage in its path.

Figure 10 shows the monthly frequency of all reported tornadoes from 1976 through 2012. All tornadoes occurred from March through October. No tornadoes have been reported during the months of

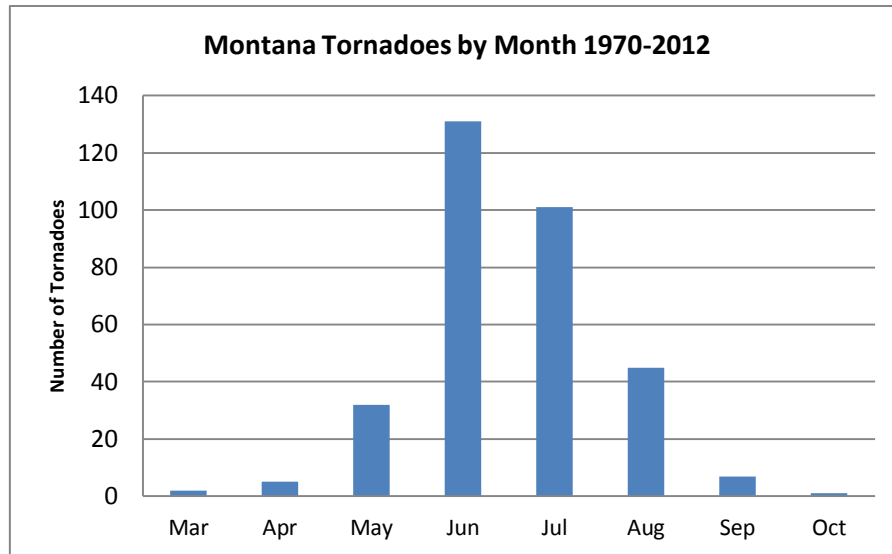


Figure 10. Tornado frequency by month.

January, February,

November or December. The earliest tornado report in the state was on March 2, 1991 near Arlee in Lake County (F0). The second earliest (F0) was March 23, 1988 near Bridger (Carbon County). The third earliest was April 22, 2003, when two tornadoes formed near Stanford in Judith Basin County (F0). The latest was on November 4, 2013 over Flathead Lake in Flathead County on the eastern shore of Woods Bay. This EF0 tornado lasted about 8 minutes. The second earliest was October 16, 1988 near Hamilton in Ravalli County (F0). The third earliest was on September 21, 1969 when an F0 touched down in Roosevelt County. The majority of tornadoes occur between 2:00 PM and 8:00 PM. Table 1 lists some of the more extreme tornado statistics for Montana.

Table 1. Some Montana tornado statistics.

Item	Year / Date	Number
Year with most tornadoes	1991	30
Month with most tornadoes	June 1991	15
Day with most tornadoes	July 5, 1988	11
Day with most casualties	Jul 26, 2010	2 fatalities, 1 injury

## 6.5 Hail

Hail ranks as the most frequent type of severe weather in Montana during the warm season, and is responsible for a large percentage of property and crop damage. Even so, no fatalities and a handful of injuries have been reported due to hail. Hail is most common in May and June, with significant reports from July, August and September. Hailstones as large as five inches in diameter have been reported in southeastern Montana, with 4.5 inch stones reported up to the continental divide in the Brady area (Fig. 11). On June 28, 1982 severe thunderstorms produced 3 inch hailstones in East Helena in Lewis and Clark County. National Guard helicopters were damaged. Hail ranged from pea to grapefruit size. Damage was estimated at \$35 million dollars from the severe hailstorm. Hail, like tornadoes and other severe, warm-season conditions, is most

likely to occur in the afternoon and early evening. The greatest percentage of severe weather events occur between 2:00 PM and 8:00 PM, as shown in Figure 12.

Montana Largest Hail Size (Inches) (1950-2012)

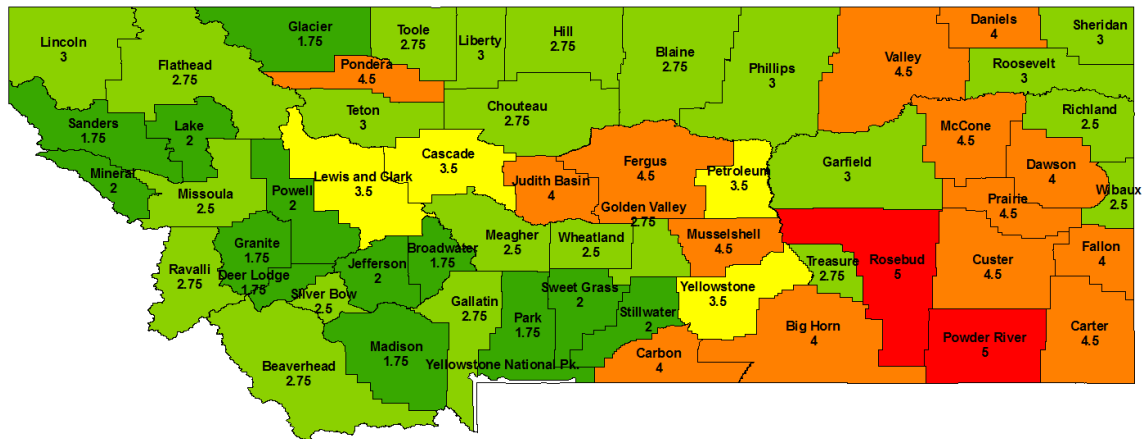


Figure 11. Largest hail size by county.

#### Largest Hailstones

- 5 inches in Rosebud County on July 11, 1955
- 5 inches in Powder River County on June 3, 1971
- 4.5 inches near Winifred in Fergus County on June 26, 1996
- 4.5 inches near Brady in Pondera County on August 13, 1991

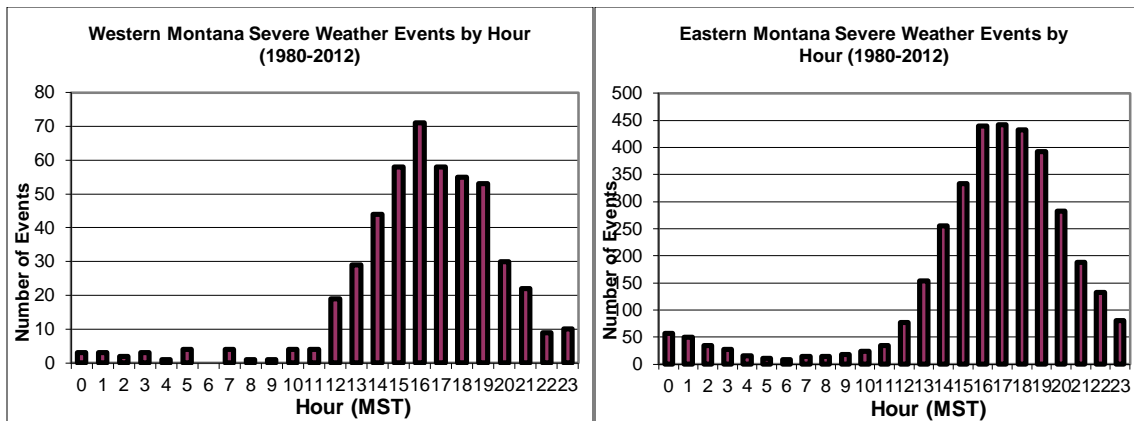


Figure 12. Severe weather events by hour west and east of the continental Divide in Montana. Note that the time of occurrence over western Montana peaks earlier than in eastern Montana. Also, there is a greater occurrence of nighttime thunderstorms and severe weather in the eastern one-third of Montana.

## 6.6 Winter Storms

Heavy snow, blizzards, and avalanches constitute winter storms. Impacts from winter storms include not only economic impacts, but also deaths, injuries and property damage. As with high wind events, winter storms often impact many counties across the state at the same time.

The weather patterns that contribute to the greatest likelihood of wintertime blizzards to occur with two scenarios.

- 1) Low pressure areas may move rapidly southeastward along the eastern slope of the Rockies followed by a major outbreak of Arctic air. The combined effects (one-two punch) also resulted in significant upsloping low level winds, producing potentially heavy snow in the upslope areas.
- 2) Another scenario is a slow moving deep low pressure center just east of the state that pulls cold polar air from the north. The onset of many winter storms are not necessarily revealed on upper level weather charts as major troughing over or near Montana as is common over the eastern half of the US.

## 6.7 Ice Storms

The conditions that produce ice storms are actually quite rare in Montana. Rain falling into pockets of below freezing surface air will create conditions that can rival the most severe blizzard. Transportation grinds to a halt, even four-wheel drive vehicles cannot achieve enough traction to go anywhere while the accumulating weight of ice on trees and powerlines will eventually cause them to come crashing to the ground. At Great Falls, ice storms are very infrequent, with about an event every other year since 1960. Havre and Glasgow have a slightly higher frequency, but still very low.

## **6.8 Microbursts**

Montana receives its share of microbursts from thunderstorms. Microbursts have produced wind speeds as high as 140 mph in the state. A microburst, along with heavy rain, caused major damage at Libby on July 21, 1997. A nearby RAWS anemometer registered 74 mph. A microburst at Neihart produced near 100 mph winds and a local forest blow-down. Microburst/straight-line winds produced major damage in eastern Montana in June 2006 as severe thunderstorms moved through the Glendive area.

## **6.9 Dust Devils**

Dust devils are also common. While most are harmless, there have been a few reports of dust devils damaging structures and producing injuries. In July 2004, 4 people were injured in the Billings area from flying debris caused by a dust devil. The highest frequency of dust devils generally occurs on days with the highest microburst potential

## **6.10 Avalanches**

Though not directly weather-related, avalanches kill about 2-3 people each winter in Montana. Back country skiers, snowmobilers and hikers are generally at greatest risk. Two of Montana's ski areas, Bridger Bowl and Big Sky, are respectively the second and fourth most avalanche-prone resorts in the United States. Avalanches have primarily affected winter recreationists who are snowmobiling or skiing.

## **6.11 Floods**

Flash floods and urban small stream floods are the most common types of floods. Riverine floods result from precipitation over large areas and/or from snowmelt. The duration of these floods may vary from a few hours to days. In 2011, a combination of heavy rain and melting snow caused one of the largest flooding events in the state's history. In April 1952, the Milk River experienced some of its greatest flooding in history. Heavy snow, snowmelt and ice jams caused the greatest flood of record on the river. Over 1000 homes flooded and nearly 3000 people evacuated. In June 1964, thunderstorms over the Rocky Mountains dropped as much as a foot of rain. Resulting conditions caused Swift Dam to fail and one of the largest floods of history in this region. Thirty lives were lost as a result of this flooding. This flood also damaged more than 350 homes near Kalispell. In January 1974, large portions of western Montana were hit by flood waters causing millions of dollars in damage to roads, bridges, buildings and other private property. In November 2009, heavy rain fell over snow in Glacier National Park and northwest Montana. Again, resulting flooding caused major infrastructure damage in the park and other areas of northwest Montana.

On July 17, 2013, a small thunderstorm produced high precipitation intensities over the Bannack area. Rates of up to 0.25-inches in 5 minutes fell over the area, even though less than 0.80-inches fell in one hour. Flash flood waters swept through the state park ghost town, causing injury to five people and damage to structures in the town.

Ice jam floods occur when ice accumulated in a river restricting flow and causing water to back up. This may result in flooding that covers large low-lying areas upstream of the jam. Downstream areas may be flooded if the jam releases suddenly, sending a flash flood downstream.